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ABSTRACT

This paper is concerned with the treatment of anaphoric phenomena in a semantically based transformation grammar. It is argued that account of anaphora in terms of coreference are no better than accounts in terms of identical NPs; instead, it is proposed that a unified account of anaphora, which covers both quantified and unquantified NPs, may be given in terms of identity of bound variables within a system that employs the device of abstraction operators. (Author)

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PRONOUNS AND VARIABLES.

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Anaphoric personal pronouns, reflexive pronouns, relative pronouns and deleted noun phrases all stand in the relation of anaphora, or 'carrying back', to some other noun phrase, usually referred to as the antecedent, although it need not in every case actually precede the other term of the relation. It is one of the tasks of grammatical theory to describe and explain this relation. In early studies in transformational grammar, it was supposed that a very simple account could be given in terms of the co-occurrence of appropriately positioned identical NPs in underlying structures. Thus, sentences such as (1a)-(4a) were supposed to be derived respectively by Pronominalization, Reflexivization, Equi-NP Deletion and Relativization from corresponding underlying structures resembling (1b)-(4b) (ignoring tense, etc.), each of which contains a pair of identical NPs.

(1) a. John said that he was tired.
b. $S[_{NP}[\text{John}]_{NP}$ say $S[_{NP}[\text{John}]_{NP}$ be tired$]_S]_S$

(2) a. Alice washed herself.
b. $S[_{NP}[\text{Alice}]_{NP}$ wash $_{NP}[\text{Alice}]_{NP}]_S$

(3) a. Tom wants to be re-elected.
b. $S[_{NP}[\text{Tom}]_{NP}$ want $S[_{NP}[\text{Tom}]_{NP}$ be re-elected$]_S]_S$

(4) a. The man who spoke to Fred was a politician.
b. $S[_{NP}[_{NP}[\text{The man}]_{NP}$ $S[_{NP}[\text{the man}]_{NP}$ spoke to Fred$]_S]_{NP}$ be a politician$]_S$

At that stage of transformational grammar, and in fact until very recently, it was generally assumed that, apart from certain exceptions such as NPs containing adjectives, which were derived from complex NPs with the adjective in the relative clause, underlying NP constituents had the same form, and occupied the same positions, as their surface counterparts. Given this assumption, it is easy to show, and in fact was recognized quite early, that the relation of anaphora cannot be explained in terms of mere identity of underlying NPs. For, in addition to sentences like (1)-(4), the grammar has to account for sentences like (5)-(7), where identical NPs are present in the surface structure and normally interpreted as referring to different persons

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with the same name.

(5) John said that John was tired.
(6) Alice washed Alice.
(7) Tom wants Tom to be elected.

If underlying NPs resemble surface NPs, these sentences must derive, like (1)-(4), from underlying structures containing identical NPs. So, unless the grammar is to be allowed to generate unrelated sentences from the same base structure, some way must be found of distinguishing between those base structures with identical NPs which do, and those which do not, trigger Pronominalization, Reflexivization or Wh-NP Deletion. For these processes at least, if not for Reflexivization, identity of NPs cannot be sufficient.

Nor, evidently, is it necessary, as is shown by cases of so-called 'sloppy identity'. (8a) is ambiguous, but it can be interpreted to mean the same as (8b), and (9a) means the same as (9b).

(8) a. Fred washed his face and so did Alice.
    b. Fred washed his face and Alice washed her face.

(9) a. Max tried to wash himself and so did Susan.
    b. Max tried $_S$[Max wash Max]$_S$ and Susan tried $_S$[Susan wash Susan]$_S$

If there are grammatical processes which account for these synonymies — VP- or S-pronominalization — they cannot be explained, within the framework of a theory which models underlying NPs on surface NPs, in terms of the identity of the underlying NPs. For at no stage of the derivation would the relevant NPs actually be identical. The only way of accounting for such processes in terms of NP identity would be to postulate base structures resembling (10) and (11).

(10) x washed x's face is true of both Fred and Alice.
(11) x tried x wash x is true of both Max and Susan.

But this would involve giving up the assumption that underlying NPs correspond in form and position to their surface counterparts, a point to which we will return.

Recognition of the inadequacy of the NP identity account of anaphora led, in the Aspects model, to the unfortunate and misguided identification of anaphora with coreference, an identification which, in one form or another, persists right up to the present. In order to distinguish between base structures for sentences like (1)-(3) and base structures for sentences like (5)-(7), the device of subscripting NPs was introduced and the relevant transformations

made to depend on subscript identity rather than NP identity. Thus, sentences like (1) were assigned base structures like (12), and sentences like (5) base structures like (13), and Pronominalization was formulated so as to be triggered by identical, and blocked by non-identical, subscripts.

(12) $S[_{NP_1}[\text{John}]_{NP_1}$ say $S[_{NP_1}[\text{John}]_{NP_1}$ be tired$]_S]_S$

(13) $S[_{NP_1}[\text{John}]_{NP_1}$ say $S[_{NP_2}[\text{John}]_{NP_2}$ be tired$]_S]_S$

But unless some account could be given of what subscripts signified, NP subscripting would be a merely ad hoc device, introduced for the sole purpose of distinguishing between otherwise identical base structures without thereby showing that there is a real distinction or, if there is, what its nature is. This is where coreference came in. One difference between (1) and (5) is that, whereas in (1), on the anaphoric reading, he is taken to have the same reference as John, in (5) the second John is taken to have a different reference from the first. So, on the basis of a very restricted range of examples such as these, it was assumed that the notion of coreference would be adequate to account for all cases where transformations are made to depend on the identity of subscripts. Identically subscripted NPs were to be taken as being coreferential, and differently subscripted ones as not being coreferential, or at least not necessarily coreferential.

However, if the notion of coreference is taken in the strict sense, according to which it means that two or more items have the same reference, and entails that there is something to which they both (or all) refer, it is easy to show that it is neither necessary nor sufficient for anaphora; and if it is not taken in this strict sense, but is intended to have some as yet undetermined sense, as it is in, for example, Postal (1970), the claim that rules involving anaphora depend on coreference is not a theory of anaphora but merely an insistence that, in the end, some notion of coreference will prove to be adequate to account for anaphoric phenomena. But if coreference in the strict sense is unsatisfactory, and no alternative notion of coreference is available, it seems reasonable at least to explore the possibility of giving up coreference altogether as the key notion in anaphora and looking elsewhere.

That coreference cannot be sufficient for anaphora is clear

from a well-known example due to Geach (1962: 132). In (14a) the two occurrences of Harry may be treated as coreferential. Yet if they were taken to stand in the relation of anaphora, Reflexivization would be triggered off, resulting in (14b); and in that case, without resort to something ad hoc, it would not be possible to account for the perfectly good sentence (14a).

(14) a. Only Harry voted for Harry.
b. Only Harry voted for himself.

There are only two possible ways of accounting for (14a,b) in the Aspects model, both of which are disastrous for that model. First, Reflexivization could be made optional, and the difference between (14a) and (14b) accounted for by saying that in the one case an optional rule has applied and in the other it has not. But that would conflict with the assumption that transformations are meaning-preserving and unrelated sentences derive from different deep structures. Alternatively, the deep structures for (14a,b) could be distinguished by the use of subscripts, in the one case both occurrences of Harry being marked with identical subscripts and in the other with different subscripts. But in that case, subscripting could no longer be treated as signifying whether NPs are coreferential or not, and would be reduced to the status of an ad hoc dodge utterly devoid of explanatory value. However, if the assumption that underlying NPs must correspond in form and position to their surface counterparts is given up, it is easy to represent the difference between (14a,b). The difference is that different predicates are ascribed to Harry; (15a), underlying (14a), ascribes the predicate x voted for Harry, and (15b), underlying (14b), the predicate x voted for x, and only the latter reflexivizes.

(15) a. x voted for Harry is true only of Harry.
b. x voted for x is true only of Harry.

That coreference is not necessary in order that two constituents should be anaphoric has already been pointed out in connection with the 'sloppy identity' examples, (8) and (9). But it is also clear from sentences such as (16).

(16) a. Fred wants to buy a unicorn and ride it to work.
b. Max dreamed that a leprechaun tried to kill him.

In (16a) it is anaphoric with a unicorn, and in (16b) the deleted subject of kill is anaphoric with a leprechaun. Yet these anaphoric constituents cannot be coreferential since they do not refer to anything. One reason why they do not refer is that the relevant objects

do not exist. But this is not crucial. In these sentences they need not refer to anything even if the relevant objects did exist. For they occur in the complements of 'mental' verbs and therefore admit of a non-specific, and hence non-referential, interpretation. Fred, for example, might not want to buy any particular unicorn, assuming such things existed, but just some unicorn or other. Yet even on this non-referential interpretation the relation of anaphora still holds. It is worth emphasizing also that it in (16a), even on the non-specific interpretation of a unicorn, is definite and contrasts with the indefinite one in (17).

(17) Fred wants to buy a unicorn and ride one to work.

It is perhaps the definiteness of it in (16a), and of other pronouns in similar constructions, that has led some theorists to think that reference and coreference must, after all, play an essential part in anaphoric phenomena. However, as we shall see, an alternative account of definiteness, and of indefiniteness, is available.

There are numerous other sorts of sentence whose derivation depends on the occurrence of anaphoric elements, but to which the notion of coreference is inapplicable. The clearest examples are interrogatives and sentences with quantified NPs. Compare sentences such as those in (18) with sentences such as those in (19).

(18) a. Who washed himself?
b. Who married his (own) mother?
c. Who wants to be rich?

(19) a. Who told Fred to wash himself?
b. Whose mother did he marry?
c. Who wants Tom to be rich?

The crucial difference is that in (18), but not in (19), the reflexive, the personal pronoun and the complement subject (deleted in (18)) are each anaphoric with the interrogative pronoun in subject position. But it makes no sense to speak of the reference of an interrogative pronoun, and hence of its standing in the relation of coreference with another constituent. A speaker who utters (18a) is not referring to anyone, as he would be if he uttered, for example, (2a). He is asking to have identified each person of whom it is true that he washed himself, and appropriate answers would be 'Fred', 'Max and Fred', 'everyone', 'nobody', and so on. The reply to (18a) may refer to one or a number of persons, but the question itself does not make any reference. Yet, whereas in (19a) the reflexive is anaphoric with

Fred, in (18a) the only constituent with which it can be anaphoric is who. Hence, in cases of this sort anaphora cannot be explained in terms of coreference, and Reflexivization cannot be made to depend on the occurrence of identical subscripts if subscript identity is to signify coreference. Postal (1972) does mark interrogative pronouns with subscripts in order to distinguish between sentences like (20a), where the personal pronoun can be anaphoric with the interrogative pronoun, and sentences like (20b), where it cannot.

(20) a. Which student said he failed the exam?
b. Which student did he say failed the exam?

But in the absence of some account of what subscripts mean in this context, such a practice is entirely ad hoc.

Of course, the meanings of (18a), (19a) and (20a,b) can be represented, and the appropriate anaphoric and non-anaphoric relations signified, if they are assigned respectively the underlying structures (21a-d).

(21) a. Who is an x such that x washed x?
b. Who is an x such that, for y=Fred, x told y[y wash y]?
c. Which student is an x such that x said x failed the exam?
d. Which student is an x such that y said x failed the exam?

But this involves giving up the assumption that underlying NPs have the same form and position as their surface counterparts.

We now turn to sentences with quantified NPs. As McCawley (1973) has pointed out, if transformations are to be prevented from arbitrarily changing meaning, distinct base structures must be assigned to (22a) and (22b). In particular, the base structure underlying (22a) must be such as to trigger Equi-NP Deletion, and that underlying (22b) such as to block it.

(22) a. Every American wants to be rich.
b. Every American wants every American to be rich.

If the phrase every American can be said to have a reference at all, it must be either the set of all Americans, in which case (22a,b) would have to be interpreted quite eccentrically, or the members of that set. If the latter, it would be intelligible, though redundant, to assign to different occurrences of every American a marker indicating identity of reference, but it would be absurd to assign markers indicating difference of reference. Moreover, in this sort of case, unlike the cases involving proper names, it is the sentence that does

not undergo Equi-NP Deletion whose complement subject is coreferential with the main subject. Whatever the precise form of the subject deleted from the complement of (22a), it cannot be coreferential with the main subject. For if it were, (22a) would mean, not that every American wants himself to be rich, but that every American wants every American to be rich, i.e., the same as (22b). So, if the notion of coreference is applicable to sentences like (22), it has the opposite effect on Equi-NP Deletion from the effect it has in sentences containing proper names. Consequently, even if the difficulties raised above for the coreference theory can be overcome, rules involving the relation of anaphora will have to be formulated so that in some contexts they are triggered by coreference and others blocked by it. And that is sufficient to undermine coreference as an explanation of anaphora.

As with the interrogative examples, quantified NPs present no problem for a theory which allows that underlying NPs differ in various ways from surface NPs. Thus, (23a) represents the meaning of (22a) and signifies the anaphoric relation between the subject of want and the subject of be rich, and (23b) represents the meaning of (22b) in which there is no relation of anaphora.

(23) a. x wants x be rich is true of every American.
b. x wants every American be rich is true of every American.

A further difficulty for the coreference theory of anaphora is raised by quantified NPs with restrictive relative clauses — and some quantifiers, such as every and each, allow only restrictive, never non-restrictive, relative clauses. It would be absurd to try to derive (24a) from (24b), especially if the two occurrences of everyone are taken to be coreferential (as they must be, given that everyone is a referential expression).

(24) a. Everyone who drives a car in Sydney has rocks in his head.
b. $_S$[Everyone $_S$[Everyone drives a car in Sydney]$_S$ has rocks in his head]$_S$

For (24b), if it is interpretable at all, implies, what is not implied by (24a), that everyone drives a car in Sydney. The point of the relative clause is precisely to restrict the class referred to by the subject of the sentence, and to express this restriction in the underlying structure it is necessary to break up the NP everyone in some such manner as in (25a,b).

(25) a. [Every [one [one drives a car in Sydney] has rocks in that one's head.
b. Every x such that x drives a car in Sydney has rocks in x's head.

Note also that underlying structures like (25) are necessary to account for the anaphoric personal pronoun in (24a) since it obviously cannot be derived from an underlying *everyone*, but only from an underlying *one* or *x*.

Another problem for the coreference theory arises in connection with restrictive relative clauses even if the head NP is not quantified. Consider sentences such as those of (26).

(26) a. {A competitor who injured himself} later killed himself.
b. {A competitor who cut his foot }

What is the reference of *himself* in the relative clause of (26a) and of *his* in (26b)? And, since both pronouns are anaphoric, what is the antecedent with which, on the coreference theory, they are coreferential? Since the antecedent of reflexives must, in general, be in the same clause as the reflexive, the relative pronoun *who*, or whatever occupies that position in underlying structure, must be the antecedent of the first *himself* in (26a) and presumably of *his* in (26b). But the relative pronoun, on the coreference theory, derives from an underlying NP coreferential with the head NP *a competitor*. So, it follows that both the relative pronoun and the other pronoun in each of the relative clauses in (26) are coreferential with *a competitor*. But what is the reference of *a competitor* in this context? If it refers at all, it clearly must refer to a (or the) competitor who injured himself/cut his foot. Consequently, if *a competitor*, *who* and *himself*/*his* are referring expressions in these sentences, they must each be coreferential with the complex NP which contains them, and this in turn must be the coreferential antecedent of *himself* in the main clause. That is, given that all the simple NPs in (26a) or (26b) are referring expressions in those contexts, they are coreferential with each other and with the complex NP subject of the sentence.

But this gives rise to a paradox of much the same sort as that which arises in relation to sentences such as (27), and which has come to be known as the Bach-Peters paradox.

(27) A boy who was only fooling her kissed a girl who really loved him.

The search for an NP to be the antecedent of *him* leads to *a boy who was only fooling her*. But this contains the pronoun *her*, so we now have to look for an antecedent for it. This search leads us to *a girl who really loved him*, which in turn contains the pronoun *him*. So any

attempt to find full NPs to be antecedents for the pronouns must fail, since such NPs would have to be infinitely deep. This argument has generally been used to demonstrate the impossibility of any theory which derives pronouns from underlying full NPs. But (27), and (26a,b), are fatal also to the coreference theory. For if him, on the anaphoric reading of (27), is to have a coreferential antecedent, there must be a referent which it and its antecedent have in common. To determine what this could be, we must find someone who satisfies the description a boy who was only fooling a girl who really loved him. But this contains him. So, assuming as we are, that him is a referential expression in this context, its reference must first be established before we can determine who satisfies the description in which it figures. This is true in general of descriptions containing referring expressions. For example, suppose we replace him in the above description by some undoubted referential NP such as Fred or the man in the brown hat. Then, in order to determine who, if anyone, satisfies the description a girl who really loved Fred and hence who, if anyone, satisfies the longer description of which this is a part, we first need to know who Fred refers to. But if him is referential in the description we are considering, its reference, unlike that of Fred, cannot be determined independently of determining who satisfies the whole description in which it figures. Moreover, our inability first to determine the reference of him, unlike a failure to determine the reference of Fred, is no barrier whatever to our determining who satisfies the description in which it figures. Further, even if, for example, John is the only boy who satisfies the description, we cannot substitute John for him in (27) and preserve the truthvalue, as we could if him were a referential expression. This can be shown by considering the situation in which (27) is false because John, the only boy who was fooling a girl who really loved him, does not kiss her. For there may be some other boy who was fooling a girl who really loved John, and who kissed her, and in that case the sentence which results from the substitution of John for him in (27) would be true. So, although him can be anaphoric in (27), if it is anaphoric it is not referential and hence not coreferential with the description in which it figures. The same is true of the pronouns in the relative clauses of (26a,b).

There is another class of cases in which anaphoric pronouns are clearly not referential, and hence not coreferential with their

antecedents. In sentences such as (28a,b), the singular reflexive cannot be coreferential with the conjoined, or disjoined, subject as the plural one may be in (28c).

(28) a. John and Fred each washed himself.
b. Neither John nor Fred washed himself.
c. John and Fred washed themselves.

A possible difficulty for the coreference theory arises from (28c) since, if it is ambiguous as between meaning that John washed himself and Fred washed himself and meaning that they washed themselves jointly, it is not clear how this difference can be expressed using referential subscripts. In (28a,b) the problem is to account for the singular reflexive. If it is coreferential with another NP, that NP must also be singular. But it is obvious that neither John nor Fred alone is an adequate antecedent for himself. If, for example, John is taken as the antecedent of the reflexive in (28a), there is no way of accounting for the fact that that sentence entails that Fred washed himself. The only course open to the coreference theorist is to mark himself with two subscripts, one identical with that attached to John and the other identical with that attached to Fred, and to maintain that the reflexive is coreferential with each of the singular NPs in the subject. This is a natural consequence of deriving (28a) from a structure like (29) by means of a conjunction reduction transformation which, in this sort of case at least, does not require strict, but only sloppy, identity of predicates.

(29) $John_1$ washed $John_1$ and $Fred_2$ washed $Fred_2$.

But apart from the failure of this treatment to account adequately for the fact that in (28a) the same predicate is asserted to hold of both John and Fred—a failure compounded by the fact that we can add and so did Tom, meaning that that same predicate is also true of Tom — this treatment fails to explain how the one occurrence of a singular reflexive can have more than one reference though it would normally have only one. By contrast, sentences such as (28a,b) present no problem for a theory which uses underlying bound variables and is not committed to the view that underlying NPs are modelled on their surface counterparts and anaphora is based on coreference. On such a theory, (28a) would be derived from a base structure roughly like (30), in which both Reflexivization and Conjunction Reduction are made applicable by virtue of variable identity.

(30) John is an x such that x washed x and Fred is an x such that x washed x.

We may take it, then, that anaphora cannot be accounted for in terms of the relation of coreference between the anaphoric elements and other surface NPs or underlying NPs corresponding closely to their surface counterparts. Where the anaphoric element and its antecedent in surface structure or in close-to-the-surface underlying structure are both referential they are coreferential; but there are coreferential NPs which do not stand in the relation of anaphora, and NPs standing in the relation of anaphora which are not coreferential. To construct anything that is likely to be an adequate account of anaphora, it is necessary to postulate underlying structures in which the NPs do not correspond to surface NPs in either form or position; in particular, to postulate structures in which NP positions are occupied by bound variables. Anaphoric phenomena can then be accounted for in terms of NP identity — i.e., variable identity — without requiring the notion of reference, or of coreference, to play any essential role. For, as we shall see, variable binding does not depend in any essential way on reference.

Logicians, in devising logical forms for sentences, long ago gave up the assumption that the NP constituents in the logical form of any sentence must correspond closely in form and position to their counterparts in the sentence itself. Linguists who have recently come to reject the same assumption are therefore following a well-established tradition. It is sometimes said that the new underlying structures are more abstract, more remote from concrete surface forms, than the old. But this is misleading, at least in so far as it suggests that there are no natural language sentences whose surface structures correspond closely to the new underlying structures. Linguists, like logicians, of necessity model their formal structures on some selected class of sentences whose surface structure is taken as the guide to the order, number and type of constituents, though the particular class selected will differ from theory to theory. The formal structures of early transformational grammar, like those of traditional (Aristotelian) logic, correspond closely to the surface form of unmarked declarative sentences. The underlying forms of generative semantics, and of modern logic, are more richly structured. Nevertheless they also correspond closely to the

surface structures of a certain class of sentences, in particular those which contain pronouns bound by some other element in the sentence. The sentences of (31) are of this sort; those of (32) are not.

(31) a. De Gaulle est-il mort?
b. The train, it is late.
c. Everyone who is a philosopher is such that he sometimes contradicts himself.

(32) a. Il est mort.
b. John said that she would be late.
c. Many people know that he lied.

The relevant difference is that in (32) but not in (31) a full NP can be substituted for the pronoun without making the resultant sentence ill-formed. Thus the sentences of (33), corresponding to those of (31) but having a full NP in the pronoun position, are ungrammatical, but those of (34), corresponding to (32), are grammatical.

(33) a. *De Gaulle est Pompidou mort?
b. *The train, the ship is late.
c. *Everyone who is a philosopher is such that Socrates sometimes contradicts himself.

(34) a. De Gaulle est mort.
b. John said that Susan would be late.
c. Many people know that Richard lied.

The pronouns of (32) are free in the sense that full NPs can be freely substituted for them. But those of (31) admit only of an anaphoric interpretation because they are bound by an antecedent; and this binding is substantially the same relation as that between binders and variables in predicate logic and in the underlying structures proposed by generative semanticists.

Another way of describing this property of the binding relation is discussed by Keenan (1971:264). Embedded sentences containing bound variables (pronouns), unlike fully independent sentences, do not have a truthvalue. They do not express propositions but specify predicates. Thus, for example, the constituent <u>he sometimes contradicts himself</u> in (31c) cannot, in that context, have a truthvalue. It would have a truthvalue if <u>he</u> were not bound and had a definite reference; but in (31c) <u>he</u> is bound. The whole sentence, (31c), itself has a truthvalue, but no part of it does. Contrast the embedded sentence in (32b), where the pronoun is not bound. Assuming that <u>she</u> refers to someone, an assumption whose truth is a condition of the whole sentence, (32b), having a truthvalue, the embedded sentence expresses a proposition and has a truthvalue in its own

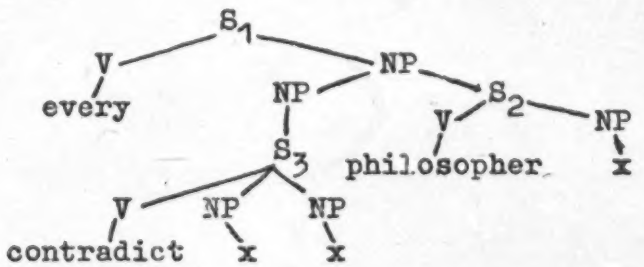
right. This contrast between the embedded sentence in (31c) and that in (32b) is closely related to the fact that a conjunction of two simple sentences, each containing instances of the same variable within the scope of the same binder, is not a conjunction of propositions but a conjunction of predicates to form a single complex predicate. Thus, in the sentence (35) the conjunction forms the complex predicate he sometimes gets confused and contradicts himself, and it is this complex predicate which the sentence attributes to every philosopher.

(35) Every philosopher is such that he sometimes gets confused and (he) contradicts himself.

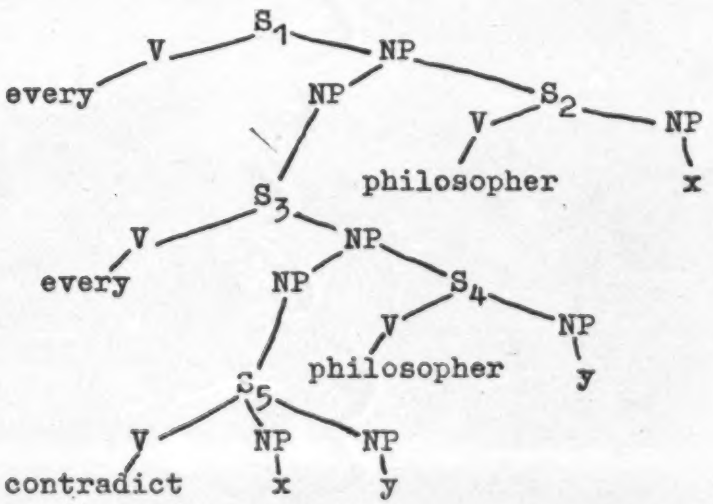
To see how a theory using underlying bound variables can account for the relation of anaphora, let us consider some examples. Following McCawley (1972), the differences between (36a) and (36b) can be explained by assigning them respectively the underlying structures (37a) and (37b), ignoring tense, etc.

(36) a. Every philosopher contradicts himself.
b. Every philosopher contradicts every philosopher.

(37) a.



b.



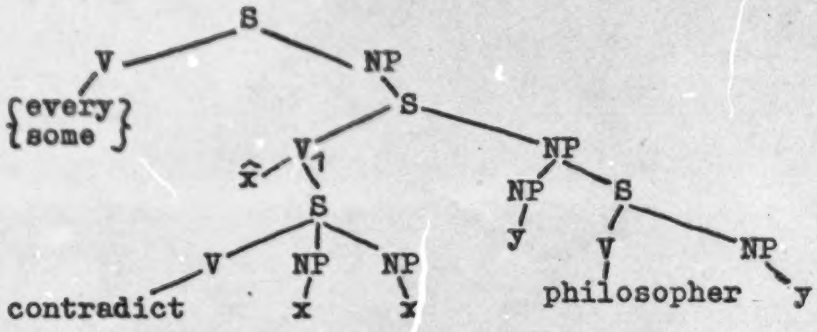
In each case, S_2 states the restriction on the quantifier and S_3 specifies the predicate attributed to every philosopher. In (37a) the predicate contains two occurrences of the variable x as clause-

mates, and it is this that triggers Reflexivization. In (37b), since there is no sub-tree in which the same variable occupies both subject and object position in a single clause, Reflexivization cannot apply. In this way the semantic difference between the two sentences is captured and the syntactic difference accounted for without relying on referential indices signifying sameness or difference of reference. What the identical variables in S_3 of (37a) signify is that if we take any x, such that x is a philosopher, that x contradicts that x; and what the different variables in S_5 of (37b) signify is that if we take any x, such that x is a philosopher, that x contradicts every y such that y is a philosopher. Unlike the subscripting device, the binding of a variable does not signify that it has a definite reference, and hence the binding of two occurrences of the same variable by the same binder does not signify that there is a definite thing to which both occurrences of the variable refer. In this sense, identical bound variables, unlike identical subscripts, are not coreferential.

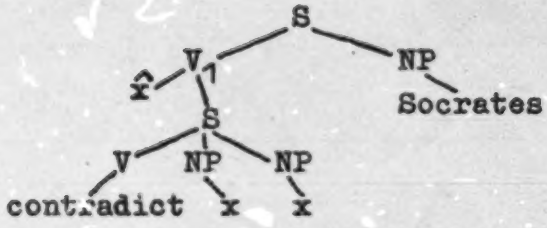
Although (37a,b) successfully identify the differences between (36a,b), there is one objection to trees of this kind. However, it is an objection which points to a defect which can easily be rectified. The objection is that, since S_3 in (37a) is not within the scope of S_2, and S_5 in (37b) is not within the scope of either S_2 or S_4, the variables in S_3 and S_5 cannot, according to the usual constraints on binding, be bound by x,y is a philosopher. The variables, therefore, appear not to be bound at all. An ad hoc move would be to say that in cases of this sort the usual constraints do not apply. A better move would be to introduce predicate abstraction operators to bind the variables. (For a detailed discussion of operators of this sort, see Thomason and Stalnaker (1973)). Besides achieving the effect of binding the variables in the predicate, this modification of the McCawley trees has the advantage of allowing a unified account of sentences ascribing the same predicate to every, some, or one member of a class. Thus, the same predicate, V_1, occurs in the trees (39a,b,c) which correspond respectively to the sentences (38a,b,c).

(38) a. {Every / Some} philosopher contradicts himself.
b. Socrates contradicts himself.
c. Only Socrates contradicts himself.

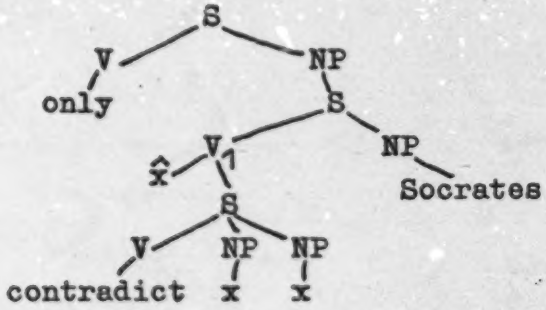
(39) a.



b.



c.



Informally, these trees may be read respectively as in (40a,b,c).

(40) a. Every (some) individual which is a philosopher is an individual such that that individual contradicts that individual.

b. Socrates is an individual such that that individual contradicts that individual.

c. Only Socrates is an individual such that that individual contradicts that individual.

In other words, the predicate <u>is an x such that x contradicts x</u> is ascribed in (39a) to every (some) philosopher, in (39b) to Socrates, and in (39c) to only Socrates. No significance attaches to the use of the two variables, <u>x</u> and <u>y</u>, in (39a) other than the fact that this makes quite explicit, what is in any case clear from the structure of the tree, that the variables in the predicate, V_1, are bound by the abstraction operator $\hat{x}$ and those in the complex NP expressing the

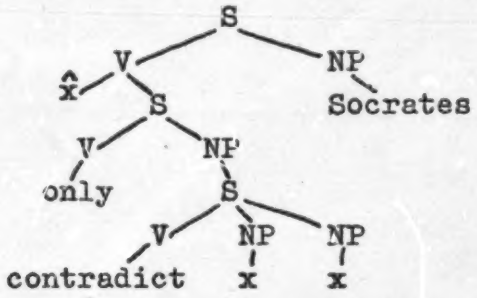
restriction on the quantifier are not bound by the abstraction operator but by the quantifier in the main clause.

In (39c), only is treated as a sentential operator like, for example, negation. But, like negation, it is not always a sentential operator but can operate on part of a predicate, as for example in the sentences of (41).

(41) a. Socrates only contradicts himself.
b. Socrates contradicts only himself.

This, however, presents no problem, at least in principle, for a theory postulating underlying structures like those in (39). For they allow for the possibility of operators such as only and negation being placed either in the predicate position in the main clause or in a predicate position within a complex predicate. Thus, on the reading in which it means that Socrates does nothing but contradict himself, (41a) can be assigned the underlying structure (42).

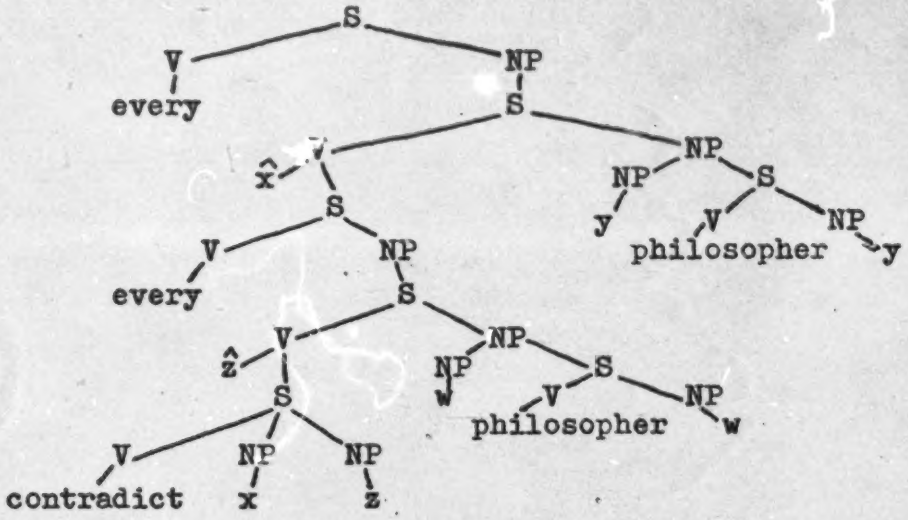
(42)



Of course only, unlike negation, is probably not a primitive predicate but rather one which derives from underlying ...and..not... In that case, it will not appear in semantic representations, and consequently (39c) and (42) will not be semantic representations. They do, however, represent remote structures underlying (38c) and (41a) respectively, and that is sufficient for present purposes.

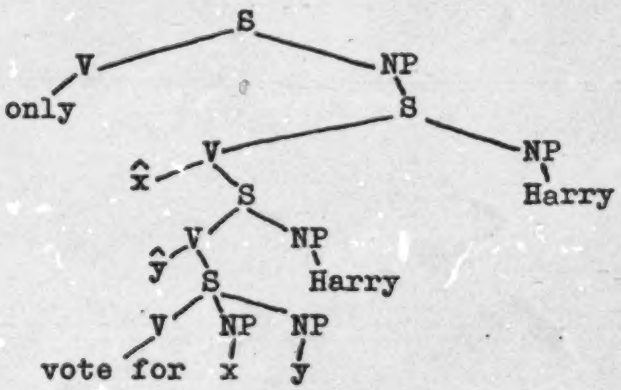
Using the device of abstraction operators to bind predicate variables, the differences between (36a,b), represented by McCawley as the differences between (37a,b), may be represented by means of the differences between (39a), which underlies (36a), and (43), which underlies (36b). Similarly, (14a,b) may be assigned the underlying structures (44a,b) respectively.

(43)



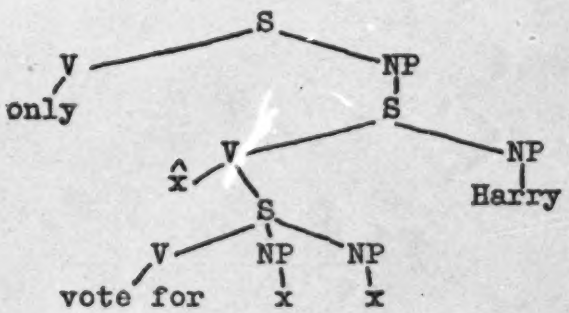
That is, every y such that y is a philosopher, is an x such that every w, such that w is a philosopher, is a z such that x contradicts z. Or, less formally: every philosopher is an individual for whom every philosopher is an individual that he contradicts.

(44) a.



That is, only Harry is an x such that Harry is a y for whom x voted.

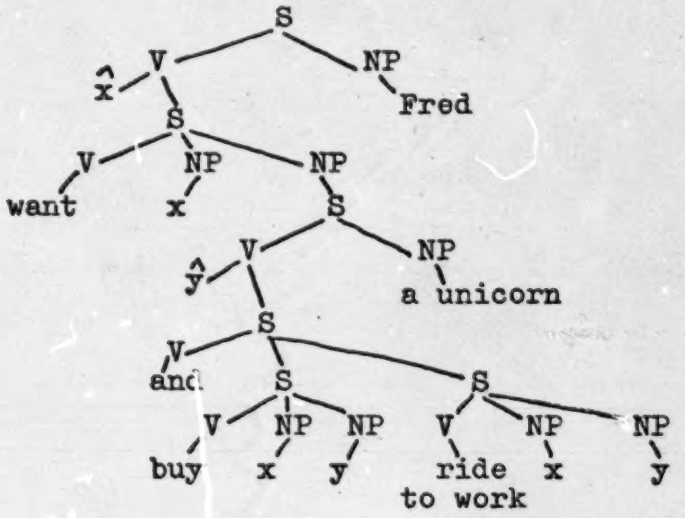
b.



That is, only Harry is an x such that x voted for x. In this case, like the others in which identical bound variables appear in the same simple clause, Reflexivization applies obligatorily. In all other cases, Reflexivization fails to apply because its structural description is not met. It is easy to see how trees of this sort

can be used to account not only for the operation of Reflexivization but also for Pronominalization and Equi-NP Deletion on the basis of identity of bound variables, thereby avoiding the troubles that arise for accounts that turn on the use of referential indices. For example, the underlying semantic representation for (16a) would be (45).

(45)



Equi-NP Deletion deletes the subject, x, of the two lowest Ss because it is identical with the subject of the main V of the predicate. A unicorn is lowered into the position occupied by y in the first of the two lowest Ss, and the y in the second of these two Ss is replaced by a pronoun because it is identical with the variable whose place is taken by a unicorn. Thus the application of these rules does not assume that there is something being referred by the pronoun or deleted NP, as is assumed by a theory using referential indices. Note also that it is the non-specific and hence non-referential reading of a unicorn in (16a) that is represented by (45). This is a consequence of the fact that a unicorn occurs in the tree within the scope of want. The specific, or referential, reading can be represented by a tree similar to (45) except that a unicorn and the operator y are placed above, and outside the scope of, the predicate want.

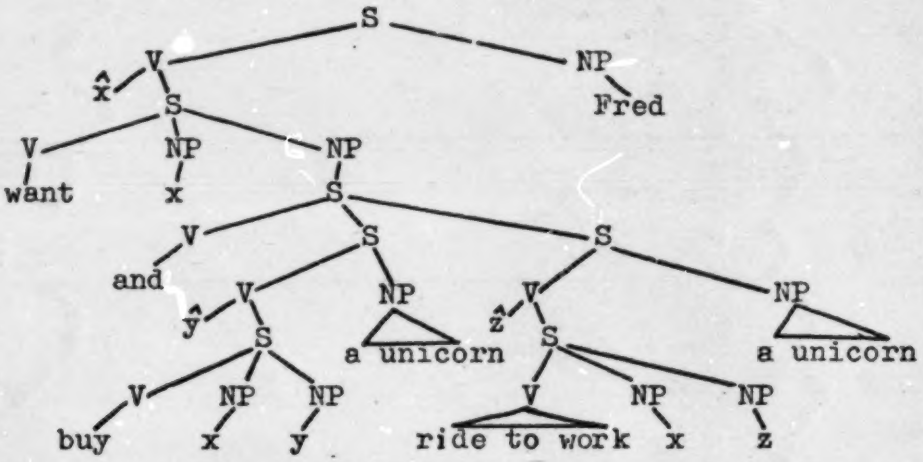
We noted earlier the difference between (16a) and (17) and the fact that in (16a), even on the non-specific reading, the definite pronoun it occurs; and it was suggested that this is partly responsible for the view that reference and coreference must in some sense be involved in any adequate account of anaphoric phenomena. However,

the definiteness of the pronoun in such contexts is a direct consequence of deriving it from an underlying bound variable. It is irrelevant whether the position occupied by the pronoun is a referential one or not. All bound variables are definite in the sense of 'carrying back' to a particular antecedent or binder. Thus, for example, (45) has to be understood as meaning (46), in which the demonstratives preceding the bound variables make explicit the fact that they are definite.

(46) Fred is an x such that that x wants a unicorn to be a y such that that x buys that y and that x rides that y to work.

Contrast (45) with (47), the underlying representation of (17), which is to be read as (48).

(47)



(48) Fred is an x such that that x wants a unicorn to be a y such that that x buys that y, and a unicorn to be a z such that that x rides that z to work.

Here, as in (45,46), the bound variables are definite, but since there is not a second occurrence of the bound variable y the rule which substitutes a definite pronoun for a variable cannot apply. Instead, a different rule inserts the indefinite one into the position occupied by the bound variable z, the condition for this operation being the double occurrence of the full NP a unicorn in appropriate positions in the tree. It may be that a more adequate representation would separate the indefinite article from unicorn in (47) and treat it as a higher predicate similar to some and every in (39a) — a treatment which would accord nicely with the account given in Perlmutter (1970) where one and a(n) are argued to have the same source — but

whatever may be the details of a satisfactory account of underlying indefiniteness, it is clear that definiteness can quite naturally be represented in underlying structure by means of the independently motivated device of bound variables.

Definiteness is represented in surface structure not only by definite pronouns but also by the definite article and demonstratives. In certain sentences, such as (49a), there is free choice between these three ways of expressing definiteness, and in each case the surface definiteness derives from the underlying definiteness of the bound variables (circled) in (49b).

(49) a. A man bought a book and later {that man / the man / he} read {that book. / the book. / it.}

b. A man is an x such that a book is a y such that (x) read (y).

For sentences such as this, where appropriate indefinite NPs are present, there is no difficulty in giving an account of the definite NPs in the surface structure. The indefinite NPs are associated with underlying binders, and the relation of binding accounts for the definiteness of the definite NPs. However, there are sentences such as (50) in which there are definite NPs but no appropriate elements to associate with underlying binders.

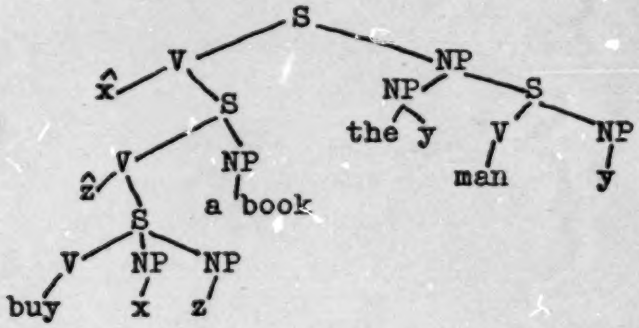
(50) {That man / The man / He} bought a book.

How is the definiteness to be accounted for in these cases? The definite NPs in (50) are just as much in need of an antecedent as those in (49). The difference is that whereas in (49) the binding is effected by something in that sentence, or its underlying structure, in (50) the binding has to be effected from outside the sentence. The subjects in (50) 'carry back' not to something expressed earlier in that sentence but to something expressed in an earlier sentence in the discourse or supplied from the extra-linguistic context. Thus the demonstrative or the pronoun can be used in a context where the speaker points to a man who can be seen by the audience. In that case the pointing stands in place of (roughly) I am pointing to a man, which contains the appropriate indefinite NP. Likewise, the definite article or the pronoun can be used in a context which includes an earlier sentence such as John saw a man and a woman, which also contains the appropriate indefinite NP. Sentences such as (50), then, are not a problem for a theory which accounts for definiteness in

terms of underlying bound variables; they simply draw attention to the need for both a discourse analysis and an account of the role of pragmatics in a grammar. An adequate account of the underlying representation of (50) will have to postulate an external binder of the form a man is an x such that ...; and it is this external binder which accounts for the presupposition carried by (50). The existence of a man is presupposed, not asserted, because the binder is not part of the sentence and because the same external binder is required by the negation of (50).

A consequence of what has just been maintained is that definite articles, demonstratives and definite pronouns do not occur in semantic representations but are introduced transformationally. A fortiori, definite articles (or their counterpart, the logician's 1) do not bind variables in semantic representations. The only binders are predicate abstracts and quantifiers, including one, two, some, every, etc. Thus (51) is not the semantic representation of (50).

(51)

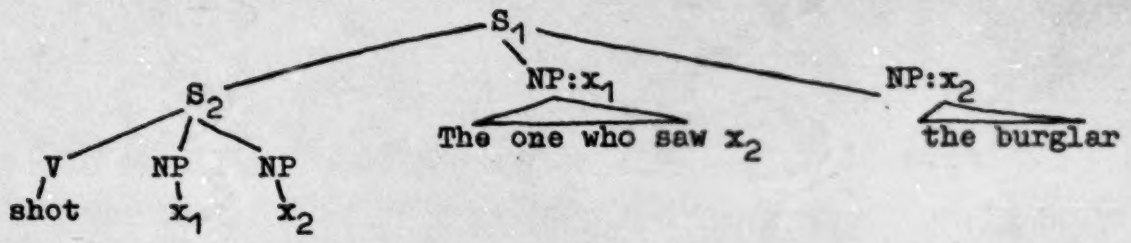


The variable y in (51) is bound from outside the tree (presumably (51) will have to be embedded in a larger, discourse tree), and since y is bound the is redundant. However, we can for convenience sometimes treat trees like (51) as if they were semantic representations, bearing in mind that, strictly speaking, the does not bind the variable but only serves to indicate that there is an external binder. With this in mind, let us now consider some sentences of the sort discussed in McCawley (1970, 1971) containing definite NPs.

McCawley discusses pairs of sentences such as (52a,b) and accounts for their synonymy by deriving them from a common underlying structure like (53).

(52) a. The one who saw the burglar shot him.
b. The one who saw him shot the burglar.

(53)



In dealing with quantified NPs, McCawley uses bound <u>variables</u>, <u>x,y</u> etc., and treats the quantifiers as higher predicates. In his account of sentences such as (52a,b), which contain definite NPs, he uses subscripted symbols to indicate that they are <u>constants</u>, not variables — i.e., symbols having specific reference — and he treats the definite NPs not as higher predicates but as external NPs — i.e., NPs originating outside the S into which they are ultimately lowered, where the lowering is determined by the subscripted symbols in the lower S and attached to the external NPs. The synonymy of (52a,b) is explained by the fact that (53), the common underlying structure, permits two different orders of lowering. To get (52a), the external NP marked x_2 is first shifted into the position occupied by x_2 in the external NP marked x_1, and then that NP is lowered into the position occupied by x_1 in S_2. This leaves the position occupied by x_2 in S_2 unfilled, and in consequence it shows up in surface structure as the pronoun in final position in (52a). To get (52b), the two external NPs are moved into the positions in S_2 occupied respectively by x_1 and x_2. This leaves the position occupied by x_2 in the NP lowered into the x_1 position unfilled, and in consequence it shows up in surface structure as the pronoun in the relative clause of (52b).

There are several objections to this way of accounting for sentences like (52a,b), all of which relate to McCawley's use of constants rather than variables. First, since x_1 and x_2 in S_2 are not variables but symbols with specific reference, S_2 is not a predicate expression or a propositional function but, as McCawley says, a <u>proposition</u>, i.e., something which has a truthvalue as it stands and is not in need of having its argument places filled. Hence, (53) is a very strange semantic representation including a proposition together with an NP coreferential with the subject and another NP coreferential with the object. The strangeness derives from the fact that, if x_1 and x_2 in S_2 really are constants — expressions with definite references —

and S_2 really is a proposition, the external NPs are unnecessary. Moreover, the lowering operation will really be a logical inference, rather than a derivation of a sentence from its semantic representation, in which two NPs are substituted for two other NPs on the grounds of coreference. If the external NPs are to be essential parts of the semantic representation, their function must be that of specifying the reference of the symbols occupying subject and object positions in S_2; and in that case, those symbols are variables which the external NPs bind. Secondly, if S_2 is a proposition rather than a predicate expression, there is a problem of accounting for what appears to be intuitively obvious, namely that (52a,b) attribute the same predicate to their subject as (54a) attributes to its, an obviousness which is reinforced by the fact that (52a,b) can be part of a longer sentence such as (54b) in which the same predicate is attributed to one specified person and denied of everyone else.

(54) a. Everyone who saw {the burglar shot him / him shot the burglar}.

b. {The one who saw the burglar shot him / The one who saw him shot the burglar} but nobody else did.

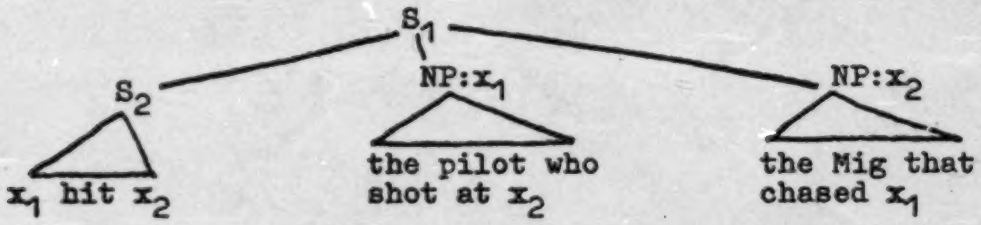
The problem for McCawley's treatment is that in the quantified cases the argument-places in the predicate expression are occupied by variables, but in the definite NP cases they are occupied by constants, with the result that the embedded S is a proposition not a predicate expression. The sentences of (54) argue strongly for an account according to which the same predicate expression can appear in the semantic representations underlying both sentences with quantified NPs and sentences with definite NPs (including proper names). As suggested above, such a unified account is possible if predicate variables are bound by predicate abstraction operators and the variables, if any, in the external NPs are bound by quantifiers. (See (43)). An alternative account of (52a,b) along these lines will be offered below.

A related difficulty with McCawley's treatment of sentences with definite NPs is that he assumes, what proves to be false, that all NP positions in such sentences are referential. This objection has been worked out in two papers by Karttunen (1969,1971). Considering sentences such as (55), Karttunen shows (1971) that they are not all unambiguous and synonymous as would be predicted by McCawley's account.

(55) a. The pilot who shot at it hit the Mig that chased him.
b. The pilot who shot at the Mig that chased him hit it.
c. The Mig that chased the pilot who shot at it was hit by him.

On McCawley's treatment, the three sentences of (55) would all derive from a single underlying representation like (56), and would accordingly be synonymous and unambiguous.

(56)



The difference between (55a,b) is explained by the fact that NP:x_1 can be lowered into the x_1 position in S_2 and NP:x_2 into the x_2 position (resulting in (55a)), or NP:x_2 can be shifted into the position occupied by x_2 in NP:x_1 and that NP then lowered into the x_1 position in S_2 (resulting in (55b)). The derivation of (55c) involves the passivization of S_2, the insertion of NP:x_1 into the position of x_1 in NP:x_2, and the lowering of that NP into the x_2 position in the passivized S_2. However, Karttunen argues that (55b,c), though unambiguous, are not synonymous, and that (55a) is ambiguous, having one reading in which it is synonymous with (55b) and one in which it is synonymous with (55c). This requires that there should be two distinct underlying representations associated with the sentences of (55).

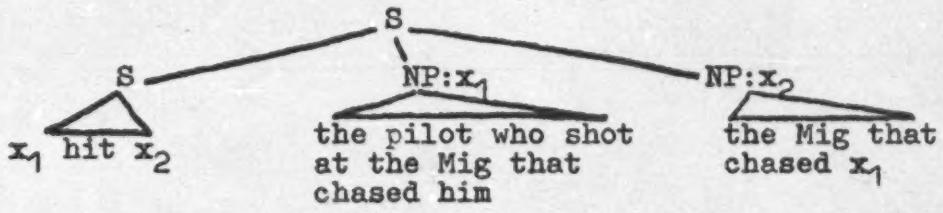
Essentially what Karttunen's argument amounts to is this. The subjects of (55b,c) are both definite descriptions and therefore require that there is a single object which satisfies the description. But since the two descriptions are different, either one could be satisfied in a situation in which the other is not. Thus the description which forms the subject of (55b) is satisfied so long as there is a unique pilot who shot at the (one) Mig that chased him. This allows that there may be many pilots each of whom was pursued by a single Mig (which may be the same or different for different pilots), but it requires that there should be only one such pilot who shot at the Mig pursuing him. The subject of (55c), however, requires that there be a unique Mig that chased the (one) pilot who shot at it; and this allows that should be many Migs shot at by a single pilot (the same or different for different Migs) as long as there is only one Mig that chased the pilot who shot at it. Now

suppose that of several pilots, each of whom is chased by only one Mig, pilot A is the only one who shoots at the Mig that chases him, and that Mig is X. Then the subject of (55b) is satisfied; the pilot satisfying that description is A and the Mig that chased him is X. Moreover, the subject of (55b) would still be satisfied by A if there were several pilots other than A who shot at X, as long as none of them is a pilot chased by X. In that situation, A would still be the only pilot who shot at the Mig that chased him. However, such a situation would not satisfy the subject of (55c). Since X is supposed to be shot at by several pilots, there is no such person as <u>the</u> pilot who shot at X, and in consequence X cannot be the Mig who chased the pilot who shot at it. Further, there may be no such Mig at all, since there may be no Mig that was shot at by a single pilot. In that case, (55c) would be neither true nor false, but (55b) would have a truthvalue and would be true if A hit X and false if A missed X. In a different situation, (55c) could have a truthvalue and (55b) be neither true nor false. Suppose, for example, that of several Migs, each of whom is shot at by only one pilot, Mig Y is the only one that chases the pilot who shoots at it, and that pilot is B. Then Y satisfies the subject of (55c) and B is the pilot who shot at it. Moreover, Y would still satisfy the subject of (55c) if there were several other Migs that chased B, as long as none of them was shot at by B. But in this situation, where B is chased by several Migs, B cannot be the pilot who shot at the Mig that chased him and cannot therefore satisfy the subject of (55b). And since there need not be any pilot chased by only one Mig, (55b) could fail to have truth value while (55c) was true or false. It follows that (55b,c) cannot be synonymous. (55b) requires that there be at least one pilot chased by only one Mig, but this is not required by (55c). On the other hand, (55c) requires that there be at least one Mig that was shot at by only one pilot, but this is not required by (55b). By similar considerations, Karttunen shows that (55a) is ambiguous and that on one reading it is synonymous with (55b) and on the other synonymous with (55c).

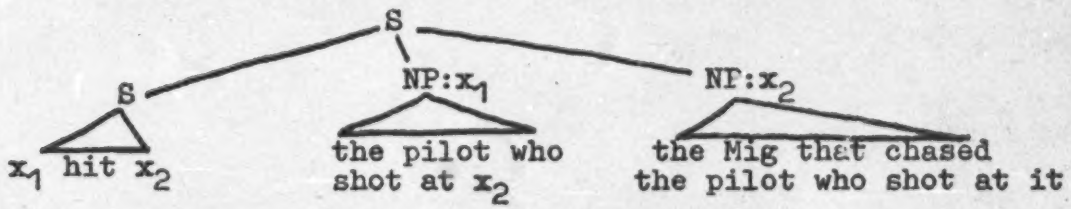
What Karttunen concludes from this is that, while some positions occupied by pronouns are 'purely referential', others are not; and he argues that there must be two sources for pronouns in semantic representation, one giving rise to referential and the other to non-

referential pronouns. In particular, the positions occupied by the indices in the external NPs in (56) cannot both be referential, and the non-synonymy of (55b,c) is said to be due to the fact that one derives from an underlying representation in which the position occupied by x_2 in NP:x_1 is referential and that occupied by x_1 in NP:x_2 is non-referential, and the other from an underlying representation in which the situation is the reverse. Following the McCawley account of the semantic representations of sentences like (55), the underlying representation for (55b), and (55a) on one reading, would have to be something like (57a), and that for (55c), and the other reading of (55a), something like (57b), where indices indicate referential positions and the pronouns occupy non-referential positions.

(57) a.



b.

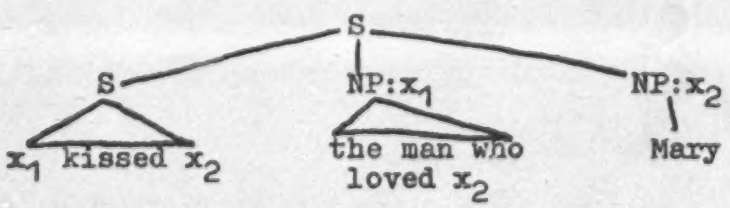


This would upset the McCawley program of deriving pronouns from underlying indices. For, in order to get (55b) from (57a), NP:x_2 must be pronominalized to <u>it</u>, and in order to get (55c) from (57b), NP:x_1 must be pronominalized to <u>him</u>.

A similar case leading to a similar conclusion is discussed in Karttunen (1969). Whereas, sentences such as (58a,b) present no problem for McCawley's analysis — they can both be derived from a common underlying structure like (59) — there is a problem with sentences such as (60).

(58) a. The man who loved Mary kissed her.
b. The man who loved her kissed Mary.

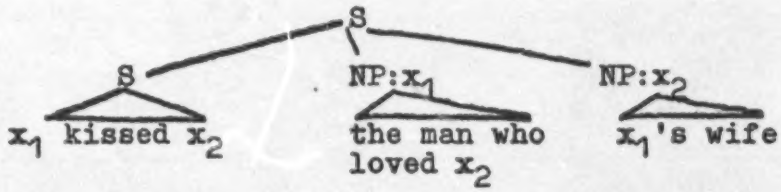
(59)



(60) The man who loved his wife kissed her.

On McCawley's account, (60) would derive from a semantic representation like (61) and would be synonymous with (62) since there are two ways in which the external NPs can be lowered into S_2.

(61)

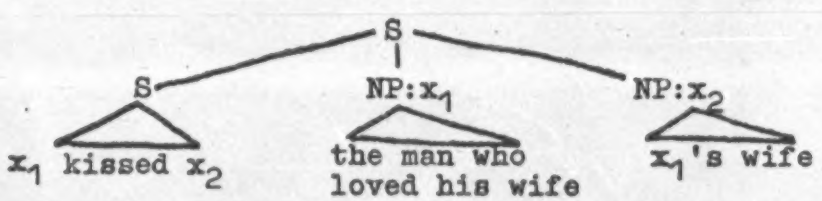


(62) The man who loved her kissed his wife.

But it is doubtful that (62) can be interpreted in the appropriate way; its most natural interpretation is that in which her refers to some independently identified person not identical with the man's wife. Moreover, (61) requires that all NP positions be referential, including the NP his wife in (60). But, as Karttunen shows, his wife in (60) cannot be purely referential. Suppose, for example, that only one man in a given universe of discourse loves his own wife and that that man is Harry and his wife is Mary, but that Mary is also loved by John. Then, in that context, (60) asserts that Harry kissed Mary. However, though we can conclude from (60), given the facts of the situation, that Harry kissed Mary, we cannot substitute Mary for his wife in (60), for that would give us a sentence whose subject is the man who loved Mary, a subject which in the situation in question is not satisfied since, because Mary is loved by both Harry and John, there is no such man as the man who loved Mary. The NP the man who loved his wife means the-own-wife-lover, not the man who loved A, where A is some independently specified person. So his wife in (60) is non-referential in much the same way as himself is non-referential in (14b) and (18a), and this is fatal to McCawley's account of its derivation.

As with the previous case, Karttunen concludes that if we are to give a McCawley-like external NP account of the underlying representation of (60), it will have to be like (63).

(63)



From this we can derive (64) directly, in which the two occurrences of his wife, the first non-referential and the second referential, have different sources; and from (64) we can derive (63), provided there is a pronominalization rule allowing the second occurrence of his wife to be replaced by her under the condition that it is an NP identical with an NP earlier in the sentence.

(64) The man who loved his wife kissed his wife.

But this not only upsets the McCawley program of deriving pronouns from underlying referential indices; it also raises again all the problems mentioned earlier associated with any account of anaphora that turns on NP identity. For it is clear that the derivation of (63) from (64) cannot be made to depend on the mere identity of the two occurrences of his wife. There is a reading of (64) in which the second occurrence of his wife refers to some independently identified person and does not in any sense carry back to the first occurrence. Somehow this reading must be distinguished from the reading according to which (63) can be derived; and since the first occurrence of his wife is non-referential this cannot be achieved by the use of referential indices. Thus, Karttunen's revision of McCawley's semantic representations is not a solution of a problem but a reductio ad absurdum of that sort of account of the derivation of pronouns. Nor is the trouble confined to pronouns; the same sort of point can be made about deleted NPs, as in sentences such as (65).

(65) The man who wanted to win broke his leg.

Suppose that there is, in some universe of discourse, only one man who wants to win and that man is Max. But suppose also that there is another man, George, who also wants Max to win. Then we can infer from (65) and the facts of the situation that Max broke his leg. But although Max wanted Max to win, he was not the only person who wanted Max to win. We cannot, therefore, substitute Max for the missing subject of win. Max is the man who wanted to win, but there is no such person as the man who wanted Max to win. Consequently, the position of subject of win in (65) is not referential. Similar points can be made about reflexives in certain contexts. The problem discussed by Karttunen, then, is a central and important one which any adequate theory of grammar must solve. It is not a peripheral issue which can be left until supposedly more central issues have been cleared up.

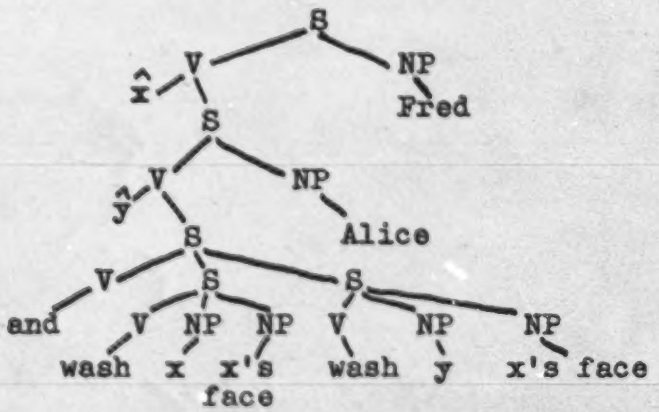
Karttunen's conclusion that there must be two sorts of pronominalization arises from the supposition that there are referential indices in semantic representations. His objection to McCawley is not that there are no referential indices in semantic representations, but that referential indices cannot account for non-referential pronouns. We have seen, however, that referential indices are not required to account for definite NPs since definiteness is a property of bound variables. We have also argued that referential indices, or constants, in trees such as (53) would render the external NPs superfluous; and from this it follows that, since the external NPs are not superfluous but are in fact essential parts of semantic representations for sentences containing definite NPs, referential indices cannot occur in semantic representations, at least not in the way they do in (53). The question to consider now, then, is whether, if referential indices are dispensed with altogether, a unified account of the derivation of pronouns can be given in terms of underlying bound variables.

One encouraging sign is the fact that, by means of bound variables and the notion of scope, it is a relatively easy matter to account for so-called sloppy identity such as in (8a).

(8a) Fred washed his face and so did Alice.

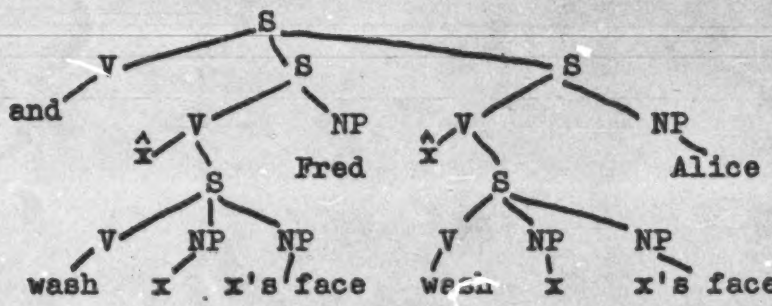
This sentence is ambiguous. On the non-sloppy identity interpretation, according to which it means that Fred and Alice both washed Fred's face, the semantic representation is (66a), and on the sloppy identity interpretation, according to which it means that each person washed his/her own face, the semantic representation is (66b).

(66) a.



That is, Fred is an x such that Alice is a y such that x washed x's face and y washed x's face. Both Fred and Alice washed Fred's face.

(66) b.



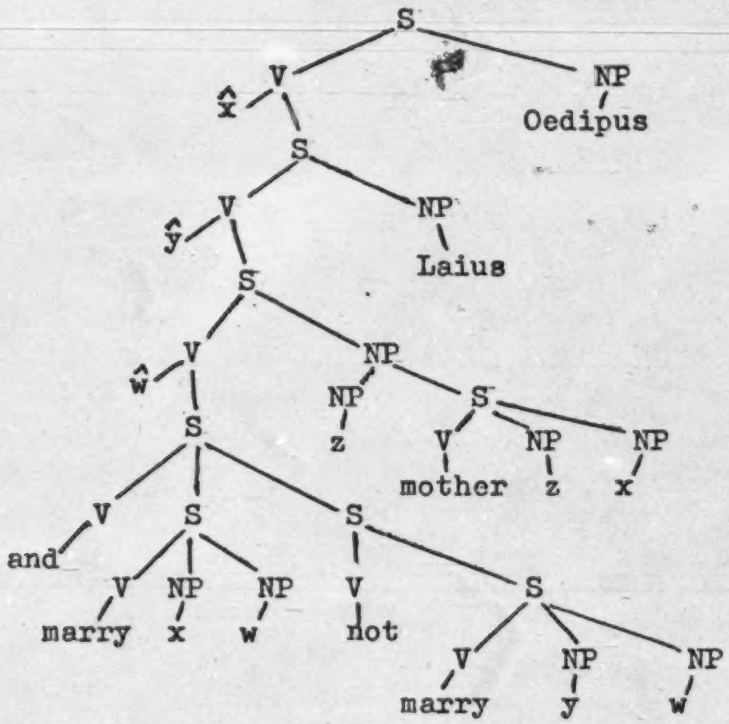
That is, Fred is an x such that x washed x's face and Alice is an x such that x washed x's face. Fred washed his own face and Alice washed her own face. In (66a), one predicate abstract is within the scope of the other. Hence, in order to keep track of the variables, it is necessary to use distinct symbols, $\hat{x}$ and $\hat{y}$. But in (66b), neither predicate abstract is within the scope of the other. Hence, there is no need to use distinct symbols. If distinct symbols were used, this would have no theoretical significance, and the use of the same symbol in both predicates makes it typographically clear that the two predicate expressions are identical, i.e., that the same predicate to wash one's own face is attributed to both Fred and Alice.

Another instructive case is the ambiguous sentence (67a), which can be taken to mean the same as either (67b) or (67c).

(67) a. Oedipus married his mother but Laius didn't.
b. Oedipus married his mother but Laius didn't marry her.
c. Oedipus married his mother but Laius didn't marry his (mother).

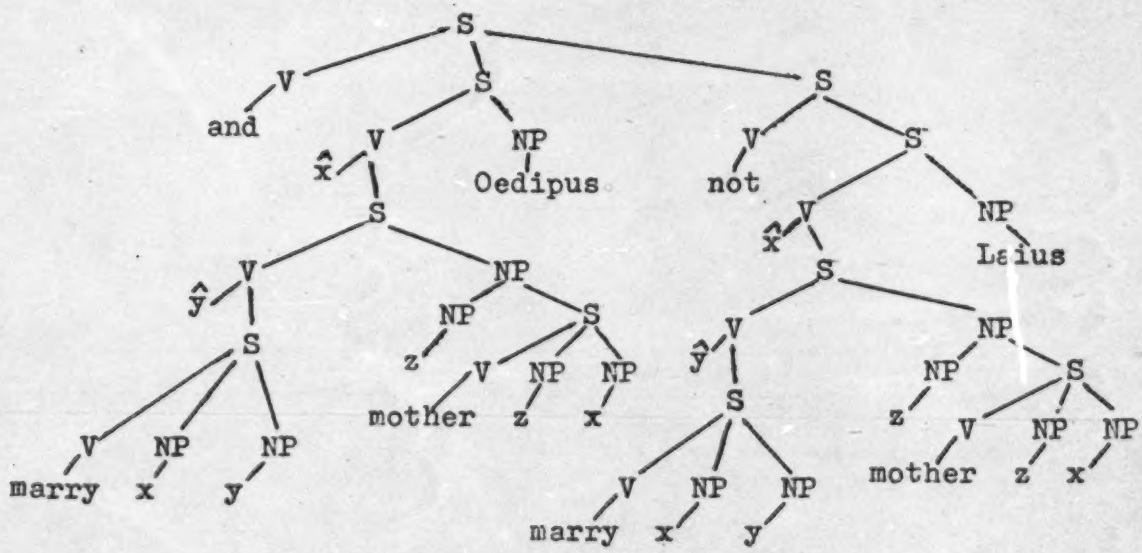
On the one reading, (67a) asserts that Oedipus married Jocasta but Laius didn't marry Jocasta. That is the reading expressed by (67b). On the other reading, the one expressed by (67c), (67a) means that Oedipus married his own mother but Laius didn't marry his own mother. On both readings, a predicate is ascribed to Oedipus and withheld from Laius. The difference is in the character of the predicates. On the first reading, the predicate is marry Oedipus' mother (= marry Jocasta); on the second reading it is marry one's own mother ($\neq$ marry Jocasta). Given that Jocasta is Oedipus' mother, we can infer from both readings that Oedipus married Jocasta, but only from the first that Laius didn't marry Jocasta. Adequate semantic representations for the two readings will have to be consistent with these logical facts. This adequacy condition is met by the two semantic representations (68a,b), where (68a) represents the meaning equivalent to (67b) and (68b) that equivalent to (67c).

(68) a.



That is, Oedipus is an x, Laius is a y, the z who mothered x is a w, such that x married w and y did not marry w.

b.



That is, Oedipus is an x such that the z who mothered x is a y such that x married y, and it is not the case that Laius is an x such that the z who mothered x is a y such that x married y.

In the trees (66) the NP x's face was left in that form because a more detailed analysis was not relevant to the point at issue. But in the trees (68) the NP x's mother is unpacked into its more

elementary components; it therefore appears as an external complex NP whose head NP, z, is assumed to be bound externally as discussed above. In this case, the binding is achieved not by a piece of earlier discourse but by the background assumption, shared by speaker and hearer, that for every person, x, there is one and only one person, y, such that y mothered x. In a context where this assumption was not shared, successful communication would require a more explicit way of binding the variable. In (68a) there is only one occurrence of the binder $\hat{x}$; different symbols for the other binders are used because they are within the scope of $\hat{x}$, and if different symbols were not used it would be impossible to keep track of the binding relationships. But in (68b) there are two occurrences of the same symbol $\hat{x}$; this is possible because each is outside the scope of the other and there is in consequence no difficulty in determining which variable is bound by which binder. By using the same symbol twice in (68b) it is possible to represent typographically the fact that in that tree the same predicate is specified twice; in one half of the tree that predicate is ascribed to Oedipus and in the other withheld from Laius. In both trees wellformedness considerations require that the NP the z who mothered x be lower in the tree than Oedipus because it contains x which has to be within the scope of its binder $\hat{x}$. For the same reason the NP the z who mothered x in the right-hand half of (68b) must be lower in the tree than Laius. However, in (68a) the respective heights of Laius and the z who mothered x is a matter of indifference; the predicate below the binder $\hat{x}$ in (68a) is equivalent to the predicate obtained by interchanging Laius and the z who mothered x and $\hat{y}$ and $\hat{w}$.

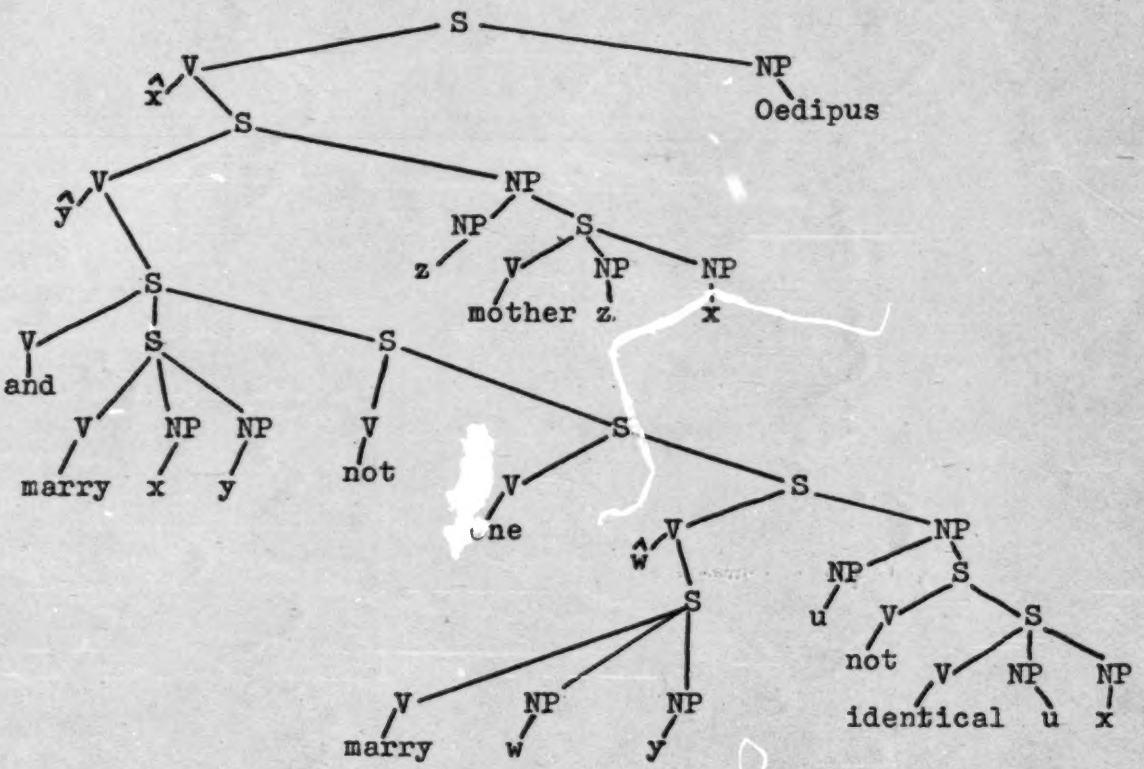
The derivation of (67a) from both (68a) and (68b) is quite straightforward. In (68a) the repetition of marry together with its object w triggers either VP deletion, yielding (67a) when the external NPs are lowered into their respective positions, or pronominalization of the second occurrence of w, thereby yielding (67b). In (68b), since the whole predicate is repeated, the second occurrence can be deleted entirely, thereby yielding (67a). Alternatively, if the second specification of the predicate is not deleted and the external NPs all lowered into their respective positions, the result is (67c), in which the second occurrence of mother is optionally deletable. Note that there is no possibility of deriving (67b) from (68b) or (67c) from (68a). The pronoun her arises in (67b) because there is only one occurrence of the complex external NP meaning the z who mother~~s~~ x in (68a), and the second occurrence of his arises in (67c) because there are two occurrences of the complex external NP. In (68a) the complex NP can be lowered into only one position, that occupied by the first w; the other w must therefore be deleted or pronominalize to her. But in (68b) both occurrences of the complex NP can be lowered, thereby filling not only the object position after the first occurrence of marry but also that after the second occurrence with the phrase his mother. This is the source of the two occurrences of his in (67c). Note also that the logical inferences mentioned above can easily be accounted for. In (68a) the only mother referred to is the mother of x, i.e. Oedipus' mother (=Jocasta). Thus it follows from (68a) that Oedipus married her but Laius didn't. But in (68b) there are two mentions of the mother of x, and in one case Oedipus is x and in the other Laius is x. So, given that Jocasta is Oedipus' mother, it follows that Oedipus married Jocasta. But in (68b) nothing is said about the relationship between Laius and Oedipus' mother.

Using trees of the same general sort as those in (68) to express underlying semantic structure, it is easy to account for ambiguous sentences such as (69a), whose two meanings are expressed by (69b,c).

(69) a. Only Oedipus married his mother.
b. Only Oedipus married his mother; nobody else married her.
c. Only Oedipus married his mother; nobody else married his (mother).

The ambiguity in (69a) is similar to that in (67a). In both cases it is stated that Oedipus married his mother; the difference is in what is denied. In (67a) it is denied that Laius married Oedipus' mother/his own mother. In (69a) it is denied that anyone other than Oedipus married Oedipus' mother/his own mother. Assuming that only is not a primitive predicate, but one which derives from an underlying ...and...not..., the two readings for (69a) are represented by (70a,b), the first representing the (69b) reading and the second the (69c) reading. (If only were a primitive predicate, it is hard to see how the ambiguity could arise).

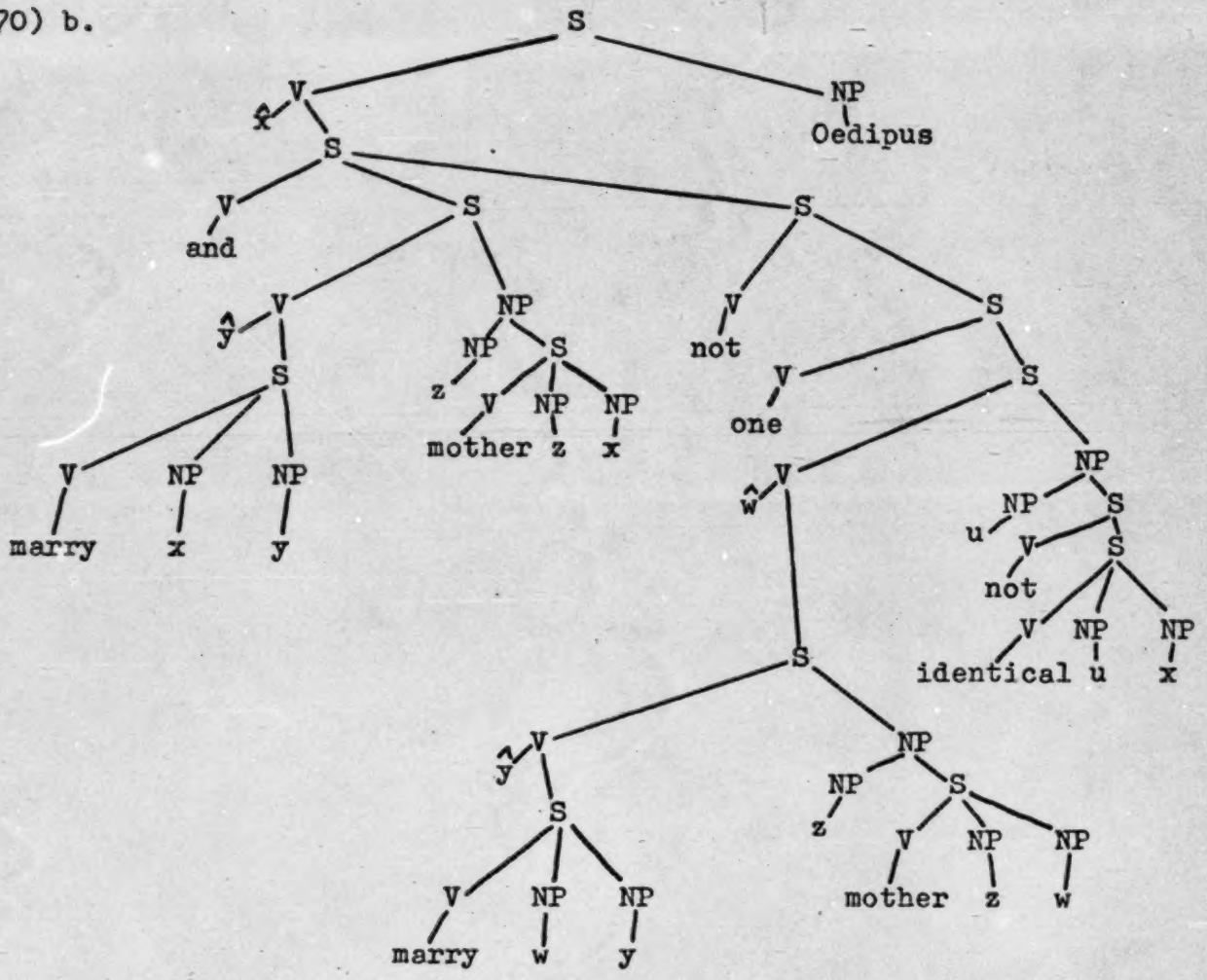
(70)a.



That is, Oedipus is an x, the z who mothered x is a y, such that x married y and no u that is not identical with x is a w such that w married y. The variable z is assumed to be externally bound as explained above. The variable u is bound by the quantifier one (= a(n)), which is treated, like all quantifiers, as a higher predicate. It is an easy matter to construct a tree semantically equivalent to (70a) in which the quantifier is every and the negation is inside the scope of the quantifier. The question whether both kinds of tree should be treated as semantic representations equivalent to each other, or whether one should be treated as derivative from the other, is left open here. The distinction between the two readings of (69a) can

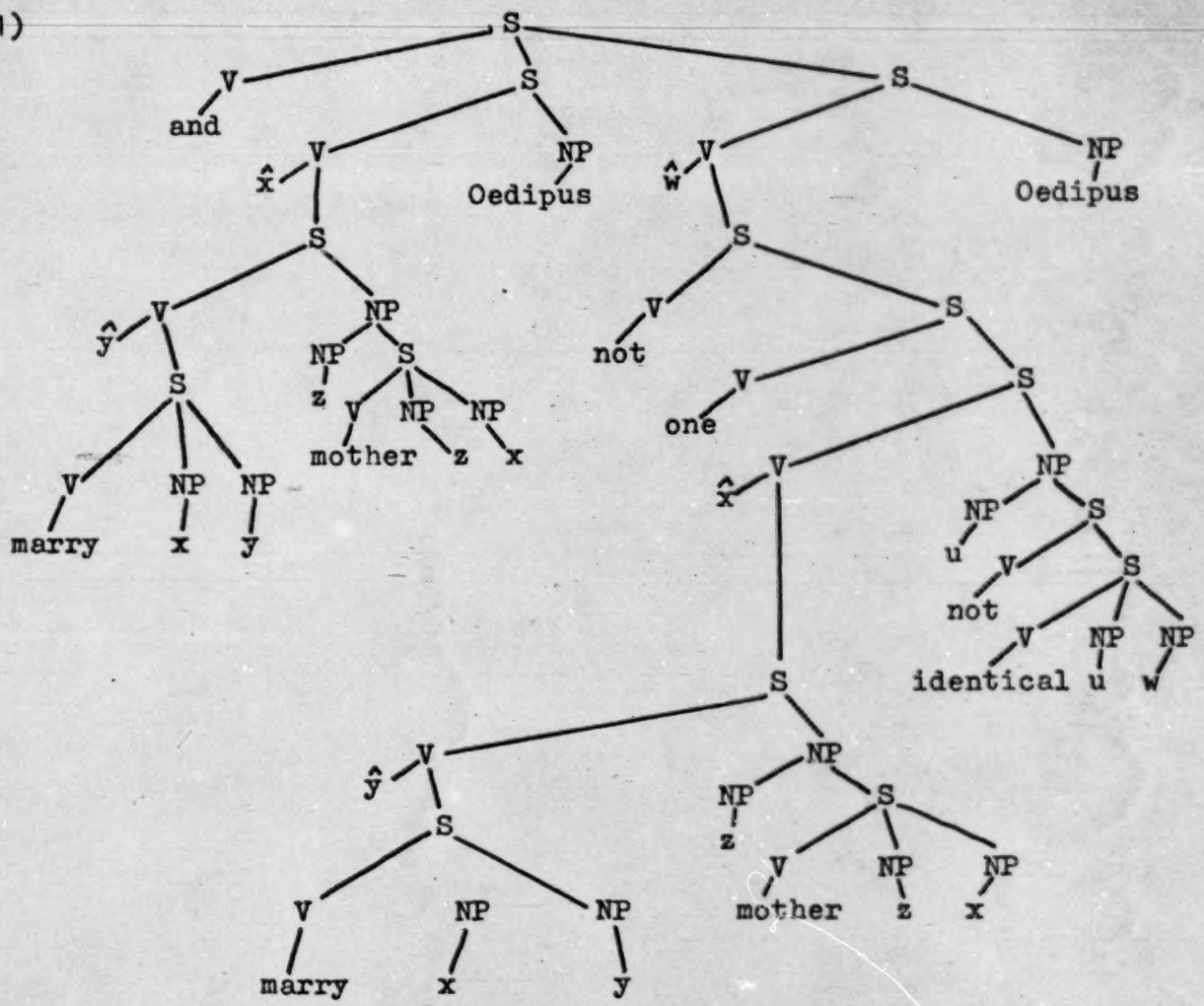
be expressed in essentially the same way whether every or one is taken to be the quantifier in the semantic representations of the two readings.

(70) b.



That is, Oedipus is an x such that the z who mothered x is a y such that x married y, and no u that is not identical with x is a w such that the z who mothered w is a y such that w married y. As pointed out above, the choice of symbols for binders is arbitrary and has no logical or semantic significance as long as the correct binding relations are kept track of. In (68b) it was possible to achieve typographical identity in the two expressions of the one predicate. In (70b) this would also be possible if and were made the top V and Oedipus occurred in both parts of the conjunction, as shown in (71).

(71)



Here the predicate ascribed to Oedipus and withheld from anyone not identical with Oedipus is expressed twice in typographically identical ways. But the double occurrence of Oedipus in (71) is a serious disadvantage since the tree does not provide for any way of showing that both occurrences are to be interpreted as referring to the same person. For this reason (70b) is preferable to (71). In (70b), since one of the NP positions associated with the predicate identical has to be within the scope of $\hat{x}$, it is not possible to express the two occurrences of the predicate ascribed to Oedipus and withheld from everyone else in typographically identical ways. In one case, the subject position of marry and the object position of mother are occupied by the symbol x, and in the other by the symbol w. The other positions can in both cases be occupied by the same symbol since z in one predicate is outside the scope of z in the other and each occurrence of $\hat{y}$ is outside the scope of the other. In these cases, it

it is a matter of indifference whether the same or different symbols are used. It is only in the case of the subject of marry and the object of mother that the requirement of keeping track of the binding relations necessitates the use of different symbols. This, however, has no semantic significance. Despite the typographical difference the same predicate is expressed in both places. Expressed informally, the predicate in question is: is an individual who married the woman who mothered that individual. In (70b) this predicate is asserted to hold of Oedipus and denied to hold of any other individual. The essential difference between (70a,b) is that whereas in (70a) only the mother of Oedipus is mentioned, in (70b) there is mention both of the mother of Oedipus and also of the mother of anyone we care to select who is not identical with Oedipus.

The derivation of (69a) from both (70a) and (70b) proceeds as follows. The first stage is to derive (72a) from (70a) and (72b) from (70b).

(72) a. Oedipus married his mother and nobody not identical with Oedipus married her.

b. Oedipus married his mother and nobody not identical with Oedipus married his (own) mother.

The derivation of (72a) results from the lowering of the external NP z who mothered x into the position occupied by the left of the two occurrences of y. Then the other y shows up as her. In (70b), since there are two occurrences of the external NP z who mothered x/w, both y positions get filled by a full NP, thereby preventing her from appearing in surface structure. And since in both cases the object of mother is identical with the subject of marry, x in the left occurrence and w in the right, the object of marry, in both cases, shows up as his mother in surface structure. This is the derivation of (72b). From both (72a) and (72b) we can derive (69a) by inserting only in place of the .... and...not... We can also derive the ambiguous (73) from both (70a) and (70b) by fairly obvious transformations.

(73) Oedipus married his mother but nobody else did.

The ambiguity in (73) is due to the fact that do can stand in for the second occurrence of marry+object in both (70a) and (70b). (On the account of non-stative verbs given in Ross (1972), do would be present above marry in both underlying structures and would show up in (73) as a result of the deletion under identity of the second

occurrence of marry+object in each case). In both (69a) and (73), it is only the derivation from (70a) that allows the substitution, given that Jocasta is Oedipus' mother, of Jocasta for his mother. On the reading represented by (70b), his mother is not a purely referential phrase.

If the account just given is correct, we have shown that sentences such as (69a) can be derived from two distinct underlying structures, representing respectively the referential and the non-referential readings of his mother, without having to resort to a rule of pronominalization of the sort envisaged by Karttunen. The question for us to tackle now is whether a similar sort of account is possible for the sorts of sentence discussed by Karttunen, (55) and (60). Following the sort of examples we have been discussing, let us consider the derivation of (74), which raises the same issues as Karttunen's sentences.

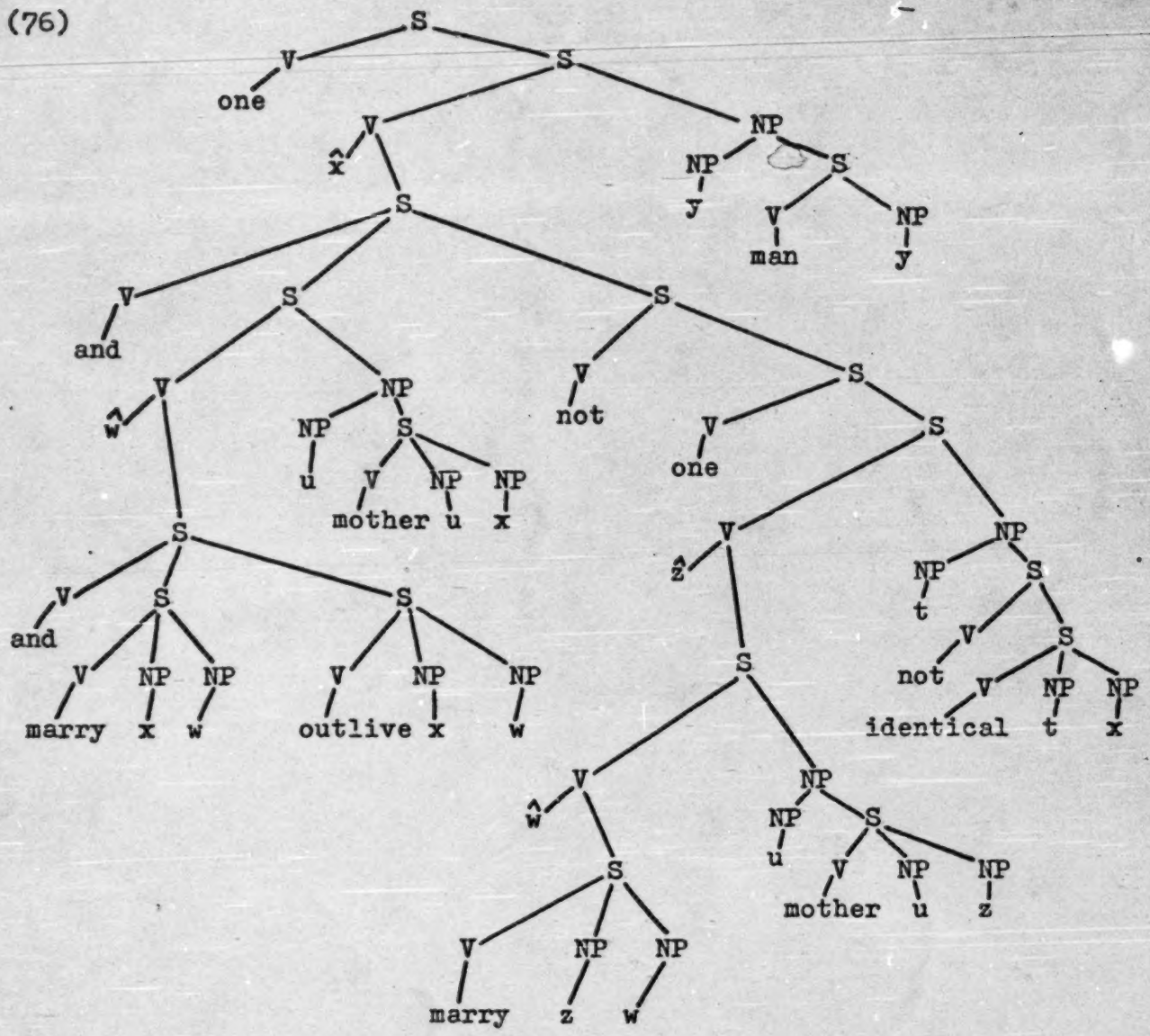
(74) The man who married his mother outlived her.

This sentence presupposes that one and only one man (in a given universe of discourse) married his mother, and it asserts of him that he outlived her. Let us therefore approach the derivation of (74) by first considering how to derive (75), in which the presupposition of (74) is contained as an explicit assertion.

(75) Only one man married his mother and he outlived her.

In both (74) and (75) the phrase his mother has to be understood non-referentially. Given that Oedipus is the only person (in a universe of discourse) of whom it is true that he married his own mother, and that Jocasta is Oedipus' mother, we cannot substitute Jocasta for for his mother in either (74) or (75). To do so would be to introduce a new presupposition into (74) and a new assertion into (75) — the presupposition/assertion that only one man married a particular woman, Jocasta — and this would change the truth-conditions of both sentences. The immediate problem, then, is to give an account of the derivation of (75) which explains why, in this context, his mother not only can, but must, be taken non-referentially. Such an account is reasonably straightforward if (75) is assigned the semantic representation (76).

(76)



That is, one y who is a man is an x whose mother is a w such that x married w and x outlived w, and no t not identical with x is a z whose mother is a w such that z married w.

From (76) we can derive (77a), which is equivalent to (75), but we cannot derive the non-equivalent (77b).

(77) a. One man married his mother and outlived her and nobody else married his mother.

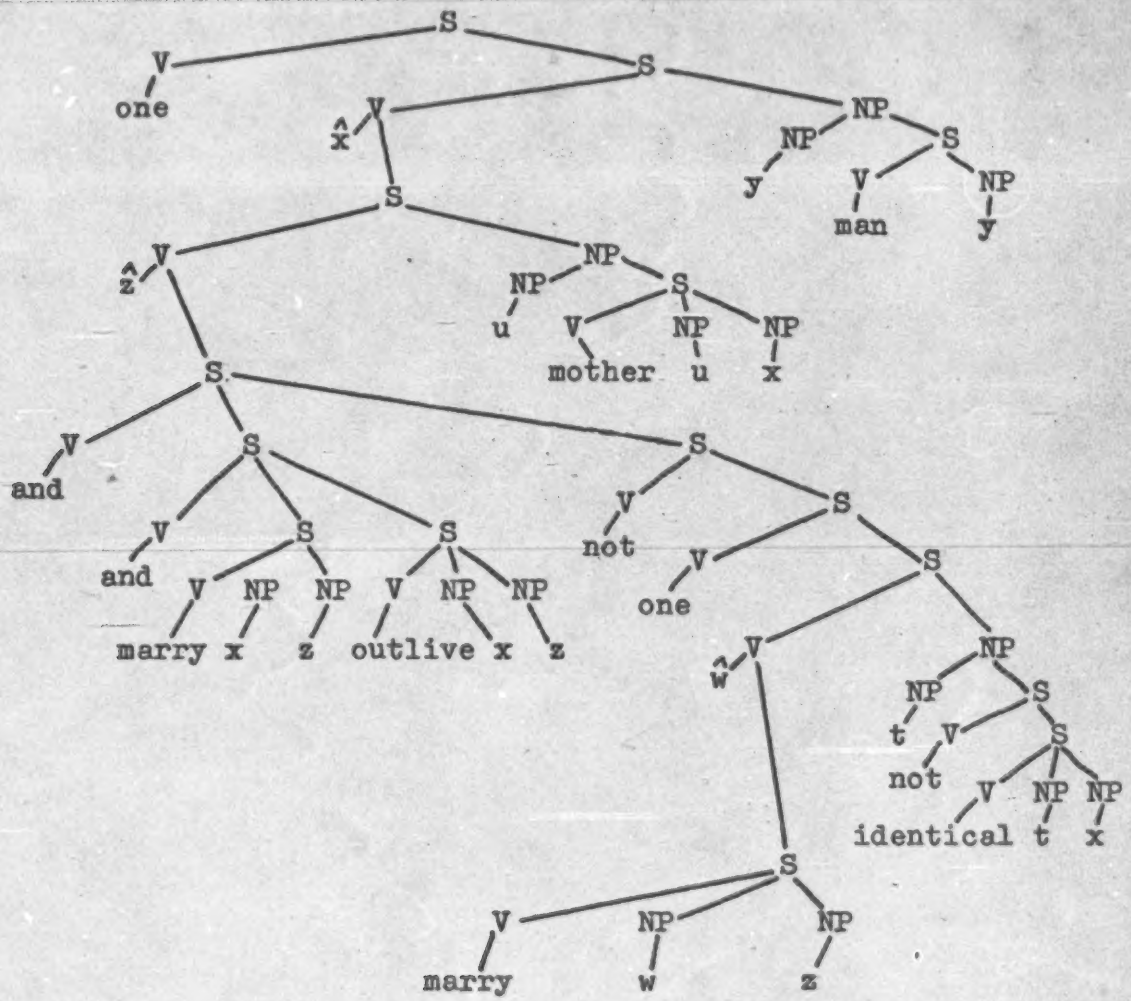
b. Only one man married his mother and outlived her.

To get (77a) we apply Conjunction Reduction to the S dominating the two predicate expressions marry x w and outlive x w and obtain the complex predicate expression marry and outlive x w. In that case the transformation which introduces only in place of ... and .. not...

is blocked, since the complex predicate ascribed to one man is not identical with the predicate denied to hold of any other man. Hence if Conjunction Reduction is applied as described, the only sentence that can be derived is (77a). The sentence (77b) could be derived only from a semantic representation differing from (76) in having the predicate outlive in the right half as well as the left half of the tree. The derivation of (75) from (76) proceeds as follows. Conjunction Reduction forming the predicate marry and outlive x w is not applied. Instead, only is inserted in place of ...and..not... on the ground that there is a predicate which is ascribed to one man and denied to hold of any other, the predicate marry+object which, after external NP lowering, is marry his mother (where his mother is non-referential). The insertion of only thus leaves the predicate expression outlive x w separate from the predicate expression marry x w, and in consequence it shows up in (76) as he outlived her. The two external NPs, y who is a man and u who mothered x, are lowered respectively into the subject and object positions of marry, and the variables associated with outlive become he and her by virtue of being identical with the variables replaced by the external NPs. Thus the derivation of (75) from (76) shows how his mother can be at once non-referential and the antecedent of the pronoun her.

It remains to be explained why (75) is not ambiguous, why his mother cannot have a referential reading as well as the non-referential one, as it does, for example, in (69a). If his mother could have a referential interpretation in (75), there would be a semantic representation differing from (76) in the same way as (70a) differs from (70b), from which (75) could be derived. There can be no doubt that (78) is a well-formed semantic representation; the question is why (79) but not (75) can be derived from it.

(78)



(79) One man married his mother and outlived her and nobody else married her.

The impossibility of deriving (75) from (78) has to do with a constraint, which it is not easy to state, on the replacement of ...and..not... constructions by only. That there is such a constraint is clear from the fact that, although (69a), in which the subject is a proper name, allows a referential as well as a non-referential interpretation of his mother, (80a) allows only the non-referential interpretation and cannot, therefore, derive from the same base as (80b)

(80) a. Only one man married his mother.

b. One man married his mother and nobody else married her.

The crucial difference between (69a) and (80a) is the quantifier one following only. This suggests that there is a constraint blocking

the replacement of ...and..not... by only in certain derivations where the top predicate is the quantifier one. No attempt is made here to state the constraint; it is simply assumed that there is such a constraint, and that it explains why (75) cannot be derived from (78), i.e., why (75) is not ambiguous.

Finally, we return to (74). The essential difference between (74) and (75) is that what is presupposed in (74) is explicitly asserted in (75). On the thesis proposed earlier, presupposition is essentially related to the notion of external binding. Sentences containing definite descriptions or pronouns with no explicit antecedents were accounted for by assuming external binders supplied either from an earlier part of the discourse or from the extra-linguistic context. If this sort of account is satisfactory it follows that the only difference between the semantic representation of (75) and that of (74) is that is the case of (75) the semantic representation (76) is to be thought of as a sentence tree whereas in the case of (74) it is to be thought of as a discourse tree. That is, from the part of (76) which means only one man married his mother - i.e., the part which, relative to (74), is external - we derive the subject of (74) - the man who married his mother. This gets inserted in the position occupied by x, the subject of outlive, and w, the object of outlive, becomes her as it does in (75). The details of this derivation may be complex, but there is in principle no difference between (74) and (75) in respect of the question why his mother is non-referential and at the same time the antecedent of her. It follows that, at least for sentences of this sort, there is no need to give up or restrict the claim that pronouns derive from underlying bound variables.

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